ZOOGOER

JULY • AUGUST 1996

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ZOOGOER

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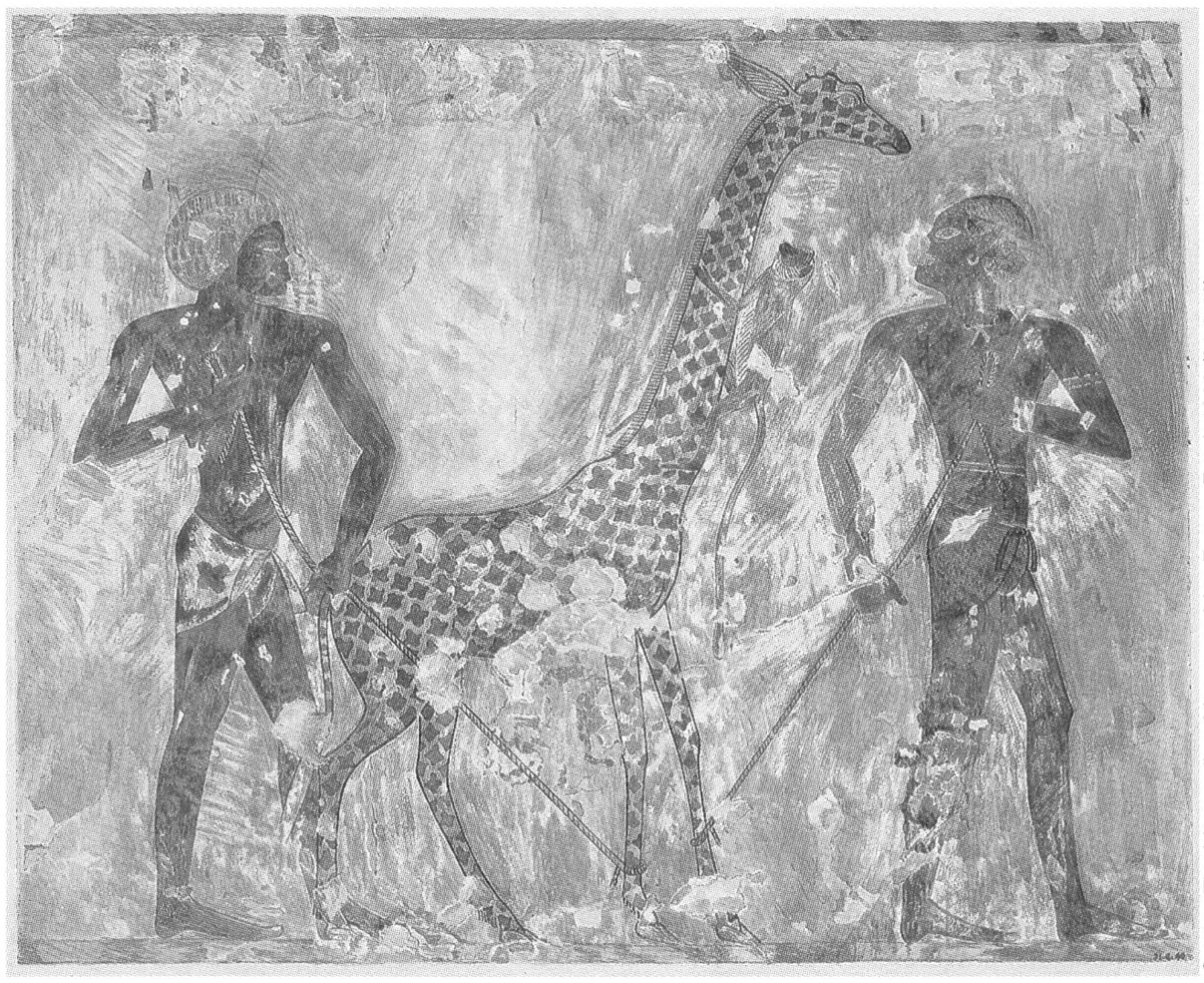
This copy of a wall painting from the Tomb of Rekhmira (circa 1475 B.C.) depicts two Nubians leading a giraffe, while a green monkey hitches a ride on the animal's neck.



DEPARTMENTS

Friends of the National Zoo

is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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Director: Michael H. Robinson.

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Sipping Your Morning Brew

FONZ members often ask me what they can do for conservation. Well, how about drinking the right kind of coffee?

What does coffee have to do with conservation? Quite a lot is the result emerging from studies by scientists at the Zoo's Migratory Bird Center and their colleagues working in the coffee-growing countries of Latin America, as described in this issue of *ZooGoer*. It turns out that traditional coffee farms, in which coffee plants are grown in the shade of canopy trees and among other crop plants, are pretty good habitat for wildlife, including many North American-breeding birds that winter in Mexico, Central America, and the Caribbean. But in some areas, shade-grown coffee is giving way to "sun coffee." Lacking a canopy of tall trees or interplantings of other crops, sun coffee farms are pretty sterile places, supporting little wildlife.

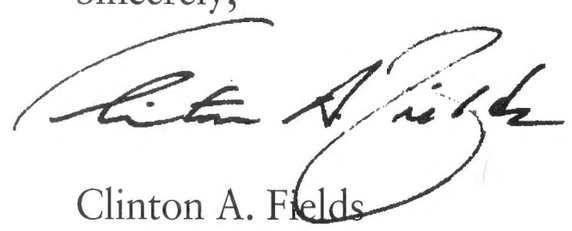
One of the things that makes conservation issues so fascinating, and often so difficult to address effectively, are these unexpected relationships between seemingly disparate events. Prosperity in the Pacific Rim, for example, has led to an increase in tiger poaching as more and more believers in traditional medicine can afford the high price of remedies laced with tiger bone. At about the same time, the collapse of the Soviet Union removed the rigid controls that made poaching rare in the Russian Far East; now it is seriously threatening the future of Siberian tigers.

The Washington Post recently reported another strange turn of events. South Carolina's Savannah River Site was for years a Department of Energy nuclear weapons facility where radioactive materials were once almost routinely spilled. Today the 310-square-mile site is an ecological marvel of healthy wildlife populations and pristine habitats—albeit ones where the deer and the ducks set Geiger counters clicking. Why this paradise among the plutonium? No people; the site has been closed to the public since 1950.

The bottom line is that virtually every change potentially has some effect on wildlife, and not always in ways we might predict off hand. Seldom, however, when we read the morning paper, do we even ask the question unless wildlife concerns are a major issue, as in an oil spill or creating a refuge. Who thought about tigers when the Berlin Wall fell? Who thinks about migratory birds when selecting coffee?

One of the goals of the new BioPark is to elucidate connections—among animals and plants, between plants and animals, and between ourselves and the rest of the natural world. The last seems to be the hardest to grasp. But it is probably the most important. So here's another thing you can do for conservation: While you sip your morning brew and skim the paper, stop to wonder about how headline events might impact wildlife and the environment. Only when we start thinking of conservation as a central concern, an issue to be addressed as part of every other issue, will true progress toward saving the planet be made.

Sincerely,



Clinton A. Fields
Executive Director

The Grind over Sun Coffee

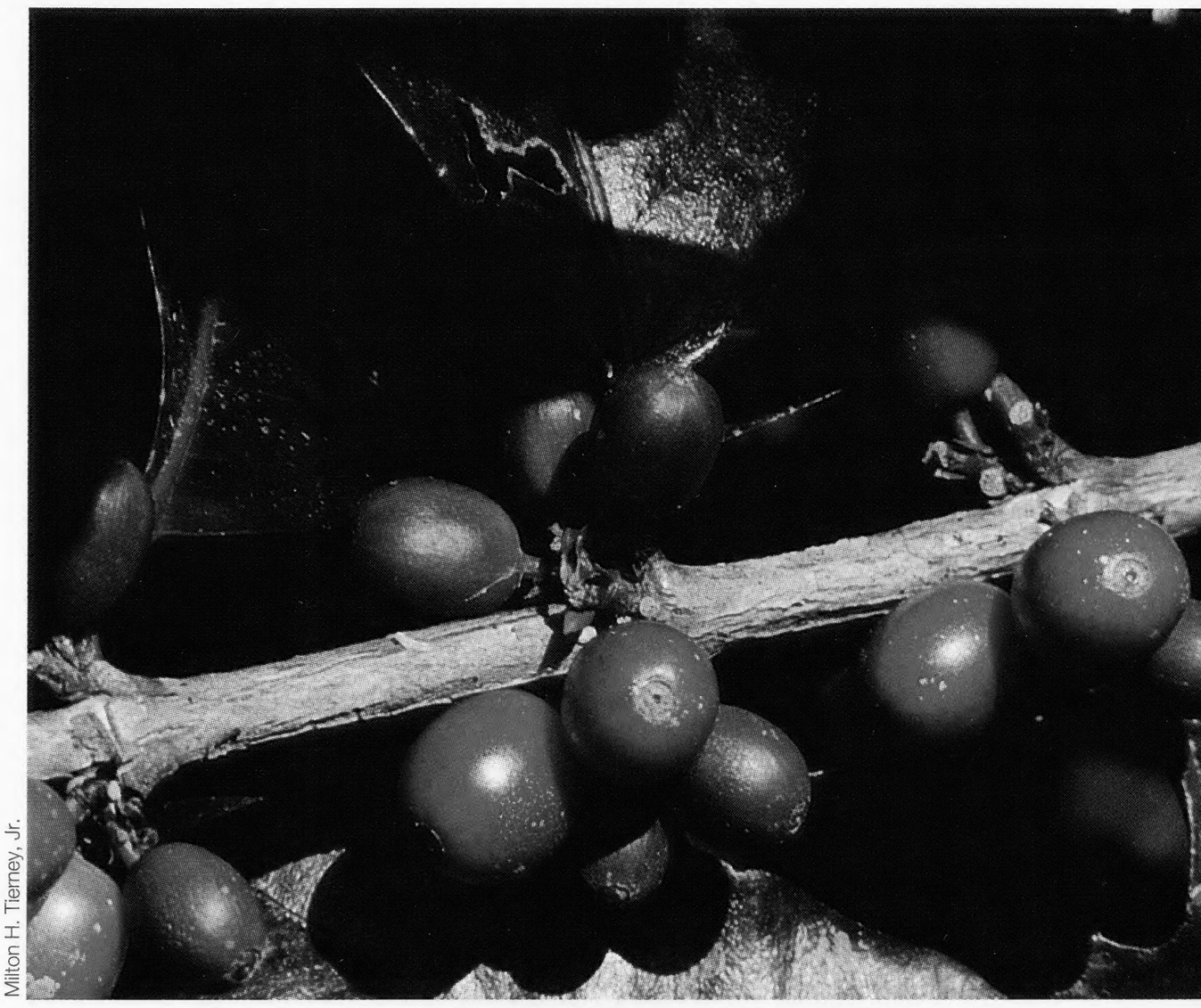
David Salvesen

Each fall, throngs of fair-weather birds from the United States and Canada venture down great avian flyways to Mexico and Central America to sit out the harsh winter until the next breeding season. Some migratory birds simply pass through this region on their way to points south. The cerulean warbler (*Dendroica cerulea*), for example, makes pit stops in Mexico and Central America on its journey from the eastern U.S. to Bolivia. However, an estimated one-third of all migratory birds that breed in the United States winter in Mexico, Central America, or the Caribbean. Teeming with migratory birds, these areas are the avian equivalent of Fort Lauderdale during spring break.

Unfortunately, with each passing year, less and less forest awaits the seasonal visitors. Much of the forestland in northern Latin America and the Caribbean already has been cleared. In the state of Vera Cruz, Mexico, for example, only about 10 percent of the original forest cover remains. With natural forests dwindling, many birds have sought refuge in the next best thing: coffee farms.

A shade-tolerant shrub, coffee traditionally has been grown beneath a canopy of native forest trees intermingled with fruit trees (tangerines, avocados, bananas, plantains, lemons) and other plants. Robert A. Rice, a geographer with the Smithsonian Migratory Bird Center (MBC) in Washington, D.C., found a total of 25 species representing 16 different families being used as shade trees in traditional coffee farms in Nicaragua. Other researchers have found more than 40 species of trees on traditional coffee farms. This pseudo-forest is attractive to a wide variety of migratory birds such as tanagers, orioles, warblers, and vireos, as well as year-round residents such as parrots, toucans, trogons, and woodcreepers. Except for the common bush tanager (*Chlorospingus ophthalmicus*), few birds actually eat coffee berries.

According to the MBC, the Baltimore oriole (*Icterus galbula*) actually seems to prefer traditional coffee farms over natural forest. "There seems to be a higher portion of nectarivorous birds in coffee plantations than in natural forests," observes Russell Greenberg, director of the



Milton H. Tierney, Jr.

Ripe red coffee berries, or fruits, are picked and the beans, or seeds, are extracted for the beloved beverage.

Summer tanagers winter from Mexico to northwest South America in traditional coffee farms and other wooded habitats. This young male is molting into adult plumage.

Center. Plantings of flowering shade trees such as those in the genus *Inga* provide abundant blossoms, catering to birds like wintering orioles, which, like some other songbird migrants, switch their diet from a staple of insects to one based primarily on nectar.

Even the habitat of coffee farms is disappearing, however. The diverse agroecosystems of traditional coffee farms are giving way to monocultures of high-yielding varieties of coffee grown in evenly spaced rows under full sun, with little or no forest canopy. These modernized or "sun" coffee plantations offer little habitat for wildlife. In fact, compared to traditional coffee farms, modern coffee plantations are biological deserts. According to Greenberg, "the few studies that have been conducted have found that the diversity of migratory birds drops dramatically when coffee is converted from shade to sun." Ivette Perfecto, associate professor of agroecology at the University of Michigan-Ann Arbor, agrees. "It's very obvious that the diversity declines dramatically," she asserts. In particular, resident birds, many of which are less adaptable and more selective in choosing where they live than migratory birds, suffer from the loss of shade coffee farms.

Humans have always converted ecosystems from complex to simple: prairies to wheatfields, rainforests to pasture. Coffee is no exception. The conversion of coffee farms from shade to sun, from complex to simple, represents another type of deforestation. "This is the other shoe falling," observes Greenberg. First, most of the region was deforested, but some habitat remained in scattered forest remnants. Now, even the habitat in coffee farms is being lost. Figures vary among countries, but in Colombia, as much as 70 percent of the coffee areas are planted with modernized coffee.

From Old World to New World

Coffee evolved as an understory shrub in East Africa, in what is now Ethiopia and Sudan. Legend has it that an Abyssinian goat herder noticed his goats became unusually frolicsome after eating bright red berries from a shrub growing wild in the pasture. He tasted the berries and soon realized their stimulating effect. The goat herder shared his discovery with a nearby monastery, which developed a beverage made from boiling the berries. The new brew enabled the monks to stay awake during evening prayers. Years later, traders brought coffee across the Red Sea into Arabia (Yemen).

The Arabians initially prepared coffee

Robert A. Rice

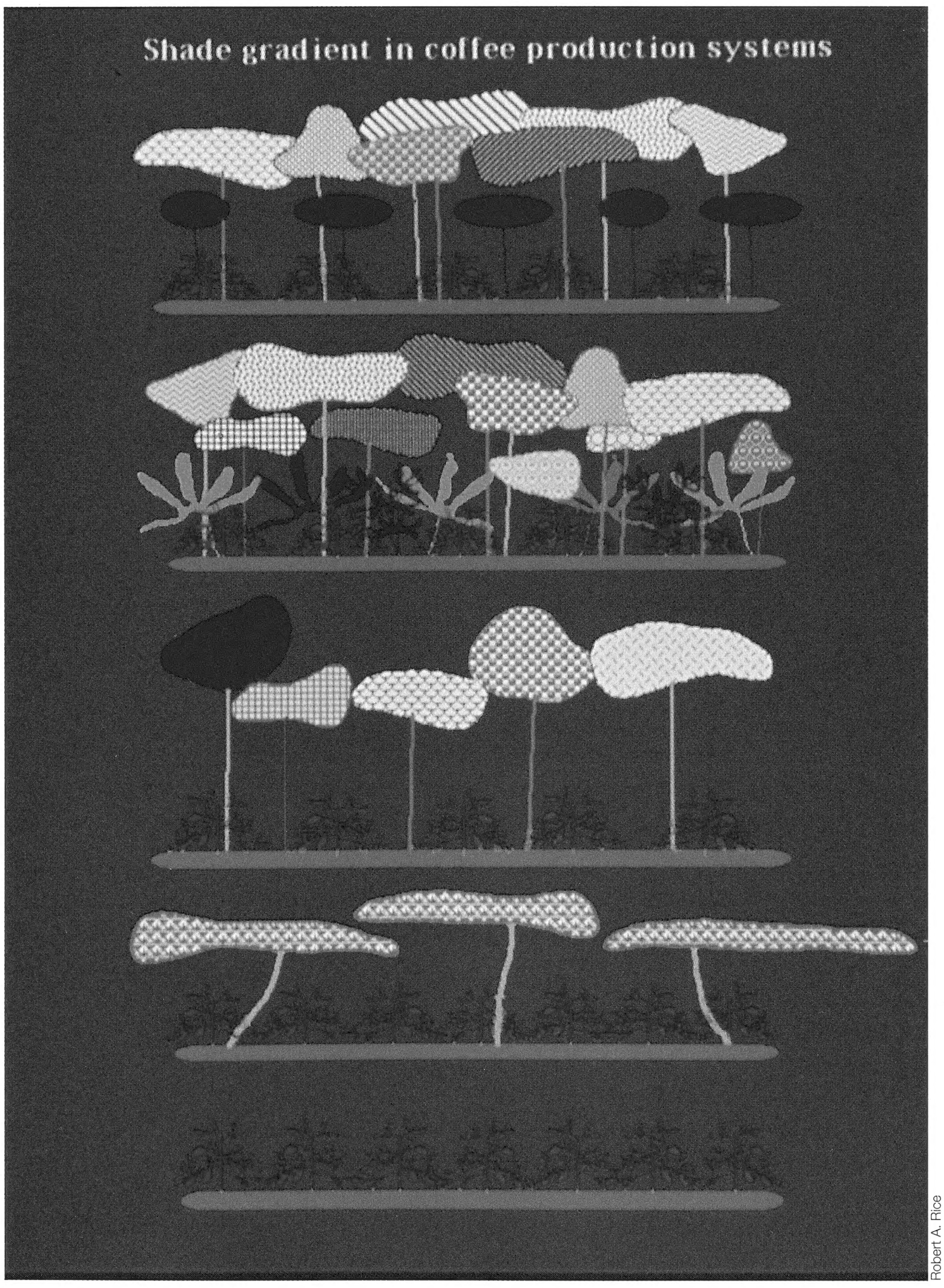
A traditional coffee farm is a multilayered ecosystem with an understory of coffee shrubs.

from green, unroasted seeds, or beans, which they extracted from the fleshy berries and then boiled in water. Later, they discovered the beans' taste improved dramatically if they were roasted and ground before adding them to boiling water. Coffee also found favor as medicine and was fermented to make wine that was used in religious ceremonies. As early as the 7th century, the Arabs began cultivating coffee. And as coffee developed into an important item of commerce, the Arabs protected their monopoly by prohibiting uncooked berries from being exported. Still, traders eventually smuggled viable seeds out of the region. By the early 1500s, coffee was being grown in Turkey, Syria, and Egypt. And by the mid-1600s, the Dutch were cultivating coffee commercially in Ceylon (now Sri Lanka) and Java.

The French, however, are credited with introducing coffee to the New World. In the early 1700s, a young French naval officer, Gabriel Mathieu de Clieu, obtained (some say stole) three coffee plants from a greenhouse in Paris and set sail for Martinique. En route, the ship apparently was beset by violent storms, pirates, and a serious water shortage. Yet somehow de Clieu managed to keep one seedling alive and planted it in the fertile Martinique soils, where it thrived. From there, coffee cultivation spread first to Brazil, where it quickly became a highly profitable export crop for the Portuguese colony, and later to the rest of Latin America.

Today, over two-thirds of the world's coffee is grown in Latin America and the Caribbean, where coffee is a major source of foreign exchange. Brazil, which got a head start on the rest of Latin America, is the world's largest exporter of coffee and accounts for over 25 percent of world production. In dollar value, coffee is the second largest legal export crop worldwide, next to oil. It is a commercially important crop in more than 50 countries, and the third largest import in the U.S., behind oil and steel.

There are two main economically important species of coffee: *Coffea arabica* and *C. robusta* (also known as *C. canephora*). Both species thrive in a hot, moist climate and rich soils. *Arabica* requires abundant rainfall and year-round temperatures of around 70 degrees, restricting its cultivation to tropical, mountainous climates at altitudes of 2,000 to 6,000 feet. *Robusta*, in contrast, grows well at lower elevations throughout the tropics. According to the Specialty Coffee Association of America, based in Long Beach, California, *arabica* beans are more



Coffee-growing methods vary along a spectrum of full shade to full sun.

delicate and flavorful than *robusta* and sell at higher prices. *Robusta* beans are often used in the processing of instant coffees and popular commercial blends. Almost all of the coffee grown in Latin America is *arabica*.

Made in the Shade

Although coffee is an introduced species in Latin America and elsewhere, its cultivation has remained virtually unchanged for over a century. A traditional coffee farm is a multilayered ecosystem with an understory of coffee shrubs, a middle level of fruit trees like avocado (*Persea americana*), and an upper canopy of native hardwoods such as Mexican cedar (*Cedrela mexicana*). The diversity of vegetation and the intermingling of different layers is what creates such rich wildlife habitat.

Generally, there is a direct correlation between the structural diversity of an ecosystem—the layers of habitat—and species diversity. This certainly holds true for most traditional coffee farms. Indeed, biologists from the MBC found that traditionally managed coffee plantations in eastern Chiapas, Mexico, support over 150 species of birds, a number exceeded only by undisturbed tropical forests.

Likewise, researchers have found the diversity of invertebrates in traditional coffee farms approaches that of undisturbed

© Robert E. Mumford, Jr.

The common yellowthroat is one of only a few migrant songbirds that commonly winter in sun coffee farms.

forest. For example, researchers at the University of Michigan found 27 species of ants and 126 species of beetles in a single tree in a shaded-coffee plantation in Costa Rica. A variety of mammals have also been seen in Mexico andCentral American coffee plantations, including foxes, weasels, kinkajous, squirrels, a variety of bats, and, in lowland areas with adjacent forest, spider and howler monkeys. This is not to say, however, that a traditional coffee farm supports the same level of biodiversity as a native forest.

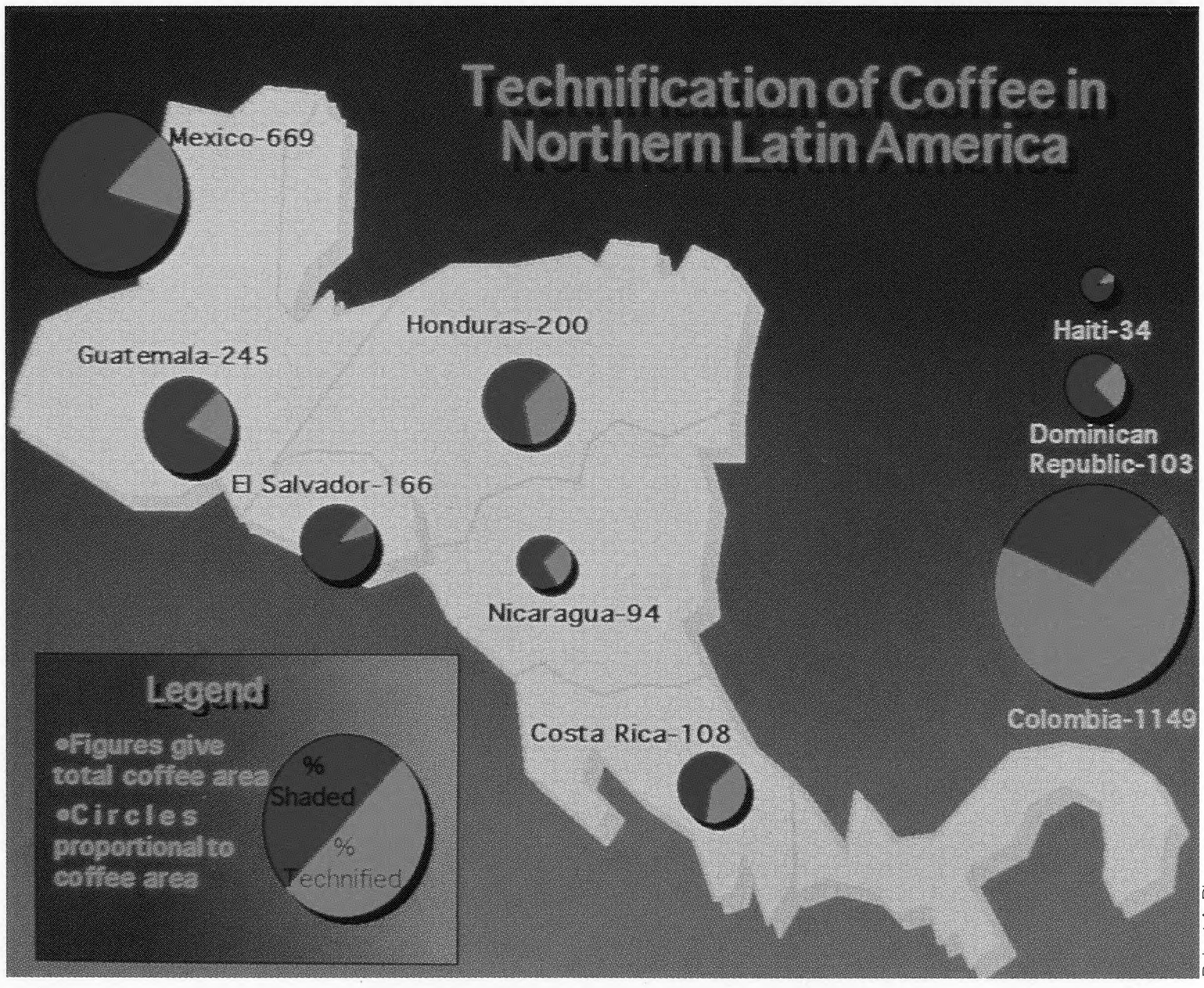
As ecologically diverse agroecosystems, traditional coffee farms not only provide a diversity of wildlife habitat, but also benefit farmers economically by providing a variety of products for local consumption and for sale. Avocados, bananas, tangerines, honey, and timber offer another source of income for traditional coffee farmers and a bit of insurance during lean times, such as when coffee prices are low.

A traditional coffee farm is virtually a self-sustaining ecosystem, with little or no pesticides, fungicides, irrigation, or fertilizers necessary. At least in the Western Hemisphere, according to Perfecto, "Coffee is not one of those crops that is loaded with insect pests." In traditional coffee plantations, predation by birds, spiders, ants, and wasps helps keep insect pests in check. Moreover, coffee's alkaloid leaves are unpalatable to most insects. Those insects that evolved mechanisms to overcome coffee's defenses probably were left behind when coffee was brought to the New World, although a relatively new arrival, the coffee berry borer (*Hypothenemus hampei*) has been wreaking havoc in coffee plantations in Nicaragua and Mexico, and is slowly spreading throughout Latin America.

Weeds and erosion generally do not cause problems on traditional coffee farms. Leaf litter forms a thick carpet of mulch, reducing evaporation, protecting the soil from erosion, and keeping weeds at bay. Also, the protective canopy buffers the soil from desiccating winds and the erosive forces of rain. The same cannot be said for modernized coffee farms.

The Industrialization of Coffee

Starting in the early 1970s, coffee farmers began to abandon time-honored growing methods in favor of more modern methods that relied on new, high-yield, densely packed, dwarf coffee plants grown in full sun, nurtured with fertilizers, and protected against attack with an array of insecticides, herbicides, and fungicides. Modern coffee farms cram 3,000 to 7,000 plants into about two and a half acres, compared



Robert A. Rice

The amount of land planted in sun coffee has been on the rise, especially in Colombia and Costa Rica. Numbers in 1,000s of hectares. (One hectare equals 2.47 acres.)

to only 1,000 to 2,000 in the same area of traditional farms. Pumped up with fertilizers, high-yielding varieties easily outproduced traditional varieties grown in shade: 1,000 to 1,300 pounds in two and a half acres for traditional versus 4,000 to 4,400 for modern farms. However, the modern plants last only about 12 to 15 years, less than half as long as traditional coffee plants.

Seduced by the prospect of higher yields, many farmers willingly chopped down the overstory, ripped out the old coffee plants, and replaced them with new ones, exposing bare soils to rain, sun, and wind—a trend that continues today. The result has been increased erosion, polluted runoff, a substantial reduction in wildlife habitat, and increased exposure of workers to hazardous chemicals. According to Rice, modern, high-tech coffee farms, sometimes referred to as "technified" farms, suffer significantly more soil erosion than farms with shade trees. Soil erosion is particularly severe on steep slopes, where coffee is commonly grown in Latin America.

Overall, the conversion from shade to sun coffee has rendered coffee farms as useless for wildlife as other tropical monocultures and raises questions about the long-term sustainability of modern coffee production methods. Norman Christensen, Jr., dean of Duke University's School of the Environment, writes in "Science and the Sustainable Use of Land" (*Land Use in America*, Island Press, 1996), "the long-term sustainability of ecosystems and landscapes across the hierarchies of ecological systems depends on complexity and diversity."

The transformation from shade to sun coffee has been supported by international development organizations such as the U.S. Agency for International Development (AID), which has spent roughly $80 million over the last 17 years to promote the technification of coffee throughout Latin America and the Caribbean. AID still has sun coffee projects in El Salvador, Honduras, Guatemala, and Haiti. The modernization of coffee-growing methods mimics the agricultural transformation that has occurred in the production of other crops such as corn, rice, and wheat, where productivity is boosted through the use of machinery and agrochemicals and by planting high-yielding varieties of these crops.

Initially, the main impetus for modernizing coffee production was to combat a fungal pest known as leaf rust (*Hemileia vastatrix*), which had devastated coffee plantations in the Old World, but did not

Howard Youth

A variety of resident birds, such as this green honeycreeper, find berries, nectar, and insects in traditional coffee farms.

find its way to the Western Hemisphere until the early 1970s, when it was detected in Brazil. Exposing coffee plants to the sun, the theory holds, dries the leaves and makes the plants inhospitable to moisture-loving fungus. If that failed, fungicides were also to be used. Yet, in Latin America, leaf rust never became the scourge it had been feared to be. Also, many of the coffee-growing regions in Latin America undergo a prolonged dry season each year, for which the rust is not well-suited. Moreover, rust fares poorly at high altitudes, where much coffee is grown. Eventually, the panic over the arrival of leaf rust subsided. Nonetheless, the switch to sun coffee continued unabated, primarily as a means to increase production.

It is difficult to make generalizations about coffee. Although the dominant trend is toward the removal of the protective canopy and an increased reliance on agrochemicals, particularly in Colombia and Costa Rica, most coffee in Latin America, Asia, and Africa is still grown the old-fashioned way—in the shade. In most coffee-growing regions, labor is still cheaper than capital (fertilizers, pesticides, and irrigation). Moreover, not all sun coffee is grown in full sun. Coffee-growing methods vary along a spectrum of full shade to full sun. "We don't have just two systems, sun and shade," explains Perfecto. "There are intermediate systems as well." Some modernized coffee farms retain up to 20 percent shade, while others are completely devoid of a canopy.

Some coffee experts are critical of the notion of politically correct coffee. "The whole focus on bird-friendly coffee is great, but it oversimplifies the issue," argues Kevin Knox, coffee buyer with Allegro Coffee (a wholesale roaster) in Boulder, Colorado. According to Knox, in parts of Kenya and Hawaii, where afternoon clouds and mist are an everyday occurrence, planting shade trees would only exacerbate problems with fungus. "Should coffee farmers [in these regions] be strung up a pole because they don't plant shade coffee? Absolutely not. They'd be foolish to plant it," states Knox. Yet, he cautions against pursuing the "ill-advised experiments of Costa Rica and Colombia. That would be a mistake for most coffee farmers."

Here and there, however, there are signs that coffee farmers are becoming dissatisfied with technified growing methods. Some have found the chemicals too expensive. Others discover that coffee yields eventually level off and in some instances drop. In Costa Rica's Central Valley, for example, where large and small

Robert A. Rice

Sun coffee plantations produce higher yields, but require heavy use of fertilizers, insecticides, herbicides, and fungicides.

farmers alike converted to sun coffee, some farmers are beginning to reestablish the forest canopy. "I have talked to several farmers who are putting trees back," states Perfecto. Some farmers are planting leguminous trees, which fix nitrogen, while others are experimenting with eucalyptus, which they can sell eventually for wood.

Outlook for Shade Coffee

Right now, consumers wanting to purchase "shade coffee" have to settle for organic coffee; for the most part, organic coffee is grown in shade. But walk into any one of Starbucks' 47 coffee shops in Washington, D.C., and you will not find certified organic coffee on the menu, although the company asserts that much of the coffee it buys is grown on traditional farms in Guatemala, Costa Rica, and Colombia and would qualify as organic. "Most of our growers cannot afford the cost of the certification process," states Tim Kern, coffee specialist with Starbucks, which is based in Seattle. In Ethiopia, almost all coffee is grown organically. "Not from any vision of political correctness," emphasizes Knox, "but because they've always grown it that way." According to Jim Stewart, founder of Seattle's Best Coffee (SBC), many growers practice organic farming simply because they cannot afford fertilizers and pesticides. SBC started offering organic coffee four or five years ago, but sales were minuscule, about five 152-pound bags a year. Now it sells about 400 to 500 bags a year. "It's the fastest growing part of our business," says Stewart.

Groups that certify crops as organic, such as the Organic Crop Improvement Association, Inc. (OCIA) in Ohio, set stiff requirements for crops that bear their labels. "We have over 40 pages of standards," states Betty Kananen, executive director of OCIA. The association requires that, at a minimum, member farms be chemical free for at least three years immediately before their certification. Farms are also subject to annual inspections. Farmers must pay a one-time membership fee of $250 plus the cost of the annual inspection (about $100 to $300). According to Kern, certification is beyond the reach, financially, of most growers. "It's a very complicated process, takes a few years, and costs a lot of money." Which is why certified organic coffee is expensive, about 10 to 30 percent more than nonorganic. Kananen notes that in some areas where several traditional coffee farms are contiguous, farmers have formed community growing groups to

The chestnut-sided warbler nests in eastern North America but winters farther south in second growth or disturbed tropical woodlands including traditional coffee farms.

share the cost of certification. This lowers the cost per farmer substantially.

The Rainforest Alliance, a nonprofit organization dedicated to preserving tropical rainforests, has developed an "ECO-OK" label for coffee that is "good for the environment and human health," but is not necessarily organic. Some ECO-OK farmers resort to chemical pesticides occasionally. "We certainly don't promote the use of chemicals, but we must be realistic," admits Elizabeth Skinner, manager of the Alliance's ECO-OK program. The Alliance's goal is to preserve traditional coffee farms by rewarding farmers who do not switch to sun coffee. "We want to provide incentives to growers to stay with shade coffee," explains Skinner. Based in Manhattan, the Rainforest Alliance works to ensure that its member farmers receive the bulk of whatever premium is charged for ECO-OK coffee. The Alliance already has developed its ECO-OK label for bananas.

The big question is whether consumers will be willing to pay more for coffee grown organically or on traditional shade-coffee farms. For Starbucks and other retailers, taste is the primary concern. "If we're going to charge a premium for coffee it must be justified in the cup," remarks Kern. That should not be a problem, according to Stewart, who asserts that "shade coffee tastes better." MBC's Rice offers one reason: "Some roasters maintain that shade coffee, which oftentimes comes from vintage varieties, has a better flavor." For some consumers, the knowledge that they may be supporting a small farmer or buying coffee from a farm that provides much-needed habitat for wildlife in Latin America may be sufficient motivation to pay the premium. The hope is that someday, buying shade coffee will be like buying dolphin-free tuna.

The Migratory Bird Center (MBC) has organized the first Sustainable Coffee Congress, which will take place from September 16 to 18, at the Smithsonian Institution in Washington, D.C. According to the MBC, the congress will bring together growers, farm workers, importers, roasters, and consumers in an attempt to develop a truly sustainable coffee for the marketplace. Co-sponsors include Starbucks, the Rainforest Alliance, the Natural Resources Defense Council, and others. For information about the Sustainable Coffee Congress, contact the MBC at 202.673.4908.

David Salvesen is a writer and environmental consultant in Kensington, Maryland.

What's a Consumer to Brew?

One goal of the first Sustainable Coffee Congress is the development of a label or other marking that identifies coffee as "shade coffee" or "bird-friendly coffee." But until such labeling becomes commonplace, there are some subtle signs conservation-minded consumers can look for when they are choosing their favorite roast.

Most specialty coffees, including those from Quartermaine Coffee Roasters of Rockville, Maryland, would probably qualify as "bird-friendly." These superior quality coffees are usually grown at higher elevations, where they encounter an increased risk of frost. Growers therefore have a greater need for a protective canopy over the coffee plants and retain more trees around the coffee plants. Because higher elevations also have fewer pests, growers rarely use pesticides. As a result, birds can feed on insects that, though not harmful to the coffee plants, would have been killed by pesticides. Most organic coffees, including Allegro Coffee, which can be found at Fresh Fields and other local grocery stores, are usually bird-friendly as well.

It may not be as simple as "sun" coffee versus "shade" coffee, however. There are gradations between complete sun and complete shade, as well as environmentally conscious producers who occasionally need to use pesticides. Some experts have proposed a star system, where growers receive one, two, or more stars depending on their use of pesticides, amount of shade, and other environmental factors.

One system, though not perfect, is already in effect. According to the people at Quartermaine Coffee Roasters, since better, more expensive varieties of coffee are usually grown at higher elevations, the more expensive the coffee you buy, the greater the likelihood that it comes from higher elevations and was grown in greater shade.

—Debra Solomon

COFFEE LUWAK

While birds and other wildlife find homes on coffee plantations, any creature that actually eats the crop would necessarily be considered a pest. Right? Well, not entirely. On coffee plantations in the south and southeast Asian range of the common palm civet, these coffee-eating carnivores are welcome members of the work force.

Weighing four to 11 pounds, the common palm civet (*Paradoxurus hermaphrodites*) is a smallish carnivore that lives largely in the trees, where it emerges at night to forage alone for a mixed diet of fruit, insects, and small mammals. While often described as catlike, palm civets could probably better be thought of as an Asian version of a raccoon or one of the raccoon's tropical relatives like a coati or kinkajou.

Like our raccoon, this palm civet has no problem co-existing with people, and is happy to take advantage of the fruits of human labor. In Asia, the palm civet is also known as the toddy cat, for its fondness for the palm juice that is tapped to make a sweet liquor called toddy. It also eats fruit crops such as mangos, melons, and bananas. On coffee plantations, palm civets dine heavily on coffee cherries. However, they are not pests because palm civets digest only the outer pulp of fruit, passing the coffee beans unharmed through their digestive systems. And because palm civets repeatedly deposit their droppings in piles at the same spots, the coffee beans are easily collected.

In some areas, these beans are merely added to the day's harvest as they are found. In others, however, workers collect these beans separately so they can be roasted then brewed into *kopi luwak*—civet coffee. Kopi luwak is reputedly the best of all coffees because palm civets pluck and eat only the most perfectly ripe cherries!

Virtually unstudied, the palm civet's foraging habits are unknown. (Few mammals, however, eat unripe fruits, so the palm civet's selectivity is not surprising.) Whether the beans are affected as they go through the animal's gut is also unknown. For that matter, there is some debate about whether coffee called kopi luwak was ever anywhere near a palm civet. In any case, coffee marketed as kopi luwak is sold—at very high prices—in Indonesia and Malaysia.

Recently, kopi luwak hit American shores, not surprisingly in California. Imported from a dealer in Europe by M.P. Mountanous in San Francisco, unroasted kopi luwak beans sell for $110 a pound. Roasted, a pound of the beans goes for $175 (!) at a Mendocino gourmet coffee shop. Asked how he knew the beans were really collected from civet scats, M.P. Mountanous representative Tom Kilty says, "We operate on trust." As for the taste, Kilty says distributor Mark Mountanous describes the brew as "gamey."

—*Susan Lumpkin*

© Cincinnati Zoo

The common palm civet.

The tallest giraffe can reach leaves more than 20 feet off the ground.

A Neck Up On The Competition

Robin Meadows

Towering over all the other animals living on the African savannas, giraffes look like creatures straight out of mythology. In fact, ancient Romans didn't quite know what to make of them, and, thinking they were crosses between camels and leopards, called them "camelopards." Compared with many other mammals, giraffes seem ungainly, disproportionate. They owe their extreme height—up to 18 feet—to the fact that many parts of their bodies are improbably long. Their legs are as long as six feet and their necks can extend an astonishing seven feet. Like most other mammals, giraffes have only seven neck vertebrae. The difference is that each giraffe vertebra can be a foot long. Even their tongues are long, with a reach of up to 20 inches. On top of all that, giraffes walk like old-fashioned wind-up toys, alternating between swinging both right legs and then both left legs forward.

While giraffes (*Giraffa camelopardalis*) may look like evolution ran amok, they are more than the sum of their parts. Their bodies are superbly adapted to browsing on leaves far above the reach of other herbivores. Rising above the competition gives giraffes virtually unlimited access to tender, nutrient-rich new growth. By stretching their necks, tilting their two-foot heads all the way back, and sticking their tongues out to the farthest extent, the tallest male giraffes can reach leaves more than 20 feet off the ground. The success of this strategy gives giraffes an edge in these days when so many species are endangered. Many ranchers don't mind sharing their grazing areas with giraffes because they don't compete with cattle for forage. Thanks in part to this co-existence, giraffes are generally still plentiful in many areas.

Our modern-day giraffes are one of only two living representatives of a once-varied group of herbivores. The first members of the giraffe family appeared in Africa about 25 million years ago and evolved into a great diversity of species as the world's sub-

The giraffe is often referred to as "the animal built by committee," an assembly of left-over parts, put together after the divine creator had run dry of ideas.

—Robin Pellew, *The Encyclopedia of Mammals*

tropical woodlands gave way to open savannas. The giraffid family had two main lineages: one characterized by long necks and the other characterized by both short necks and large horns resembling moose antlers. Giraffids lived throughout Africa and southern Eurasia in a swath from Spain to China as recently as two million years ago. However, the diversity and range of giraffids later declined during the ice ages of the Pleistocene due to their dependence on subtropical climes. Today giraffes are found only south of the Sahara, and most live in East African national parks and reserves. The only other surviving giraffid is the okapi (*Okapia johnstoni*), an elusive short-necked species found in the tropical forests of Zaire.

Giraffes have a great capacity to spark our imaginations, as Newt Gingrich showed when he told his students that men are "biologically driven to hunt giraffes." But for all the enthusiasm that giraffes inspire, their natural history is still mostly a mystery. This dearth of knowledge is due less to a lack of curiosity on the part of biologists than to a lack of financial support. "It's hard to get funding to study them because they're not endangered," says ecologist Tim Ginnett, who recently completed his doctorate on giraffe foraging behavior at the University of California at Davis (UCD) and is now at Texas A&M University studying foraging in deer. "Much of the money goes to elephants, rhinos, and other endangered species."

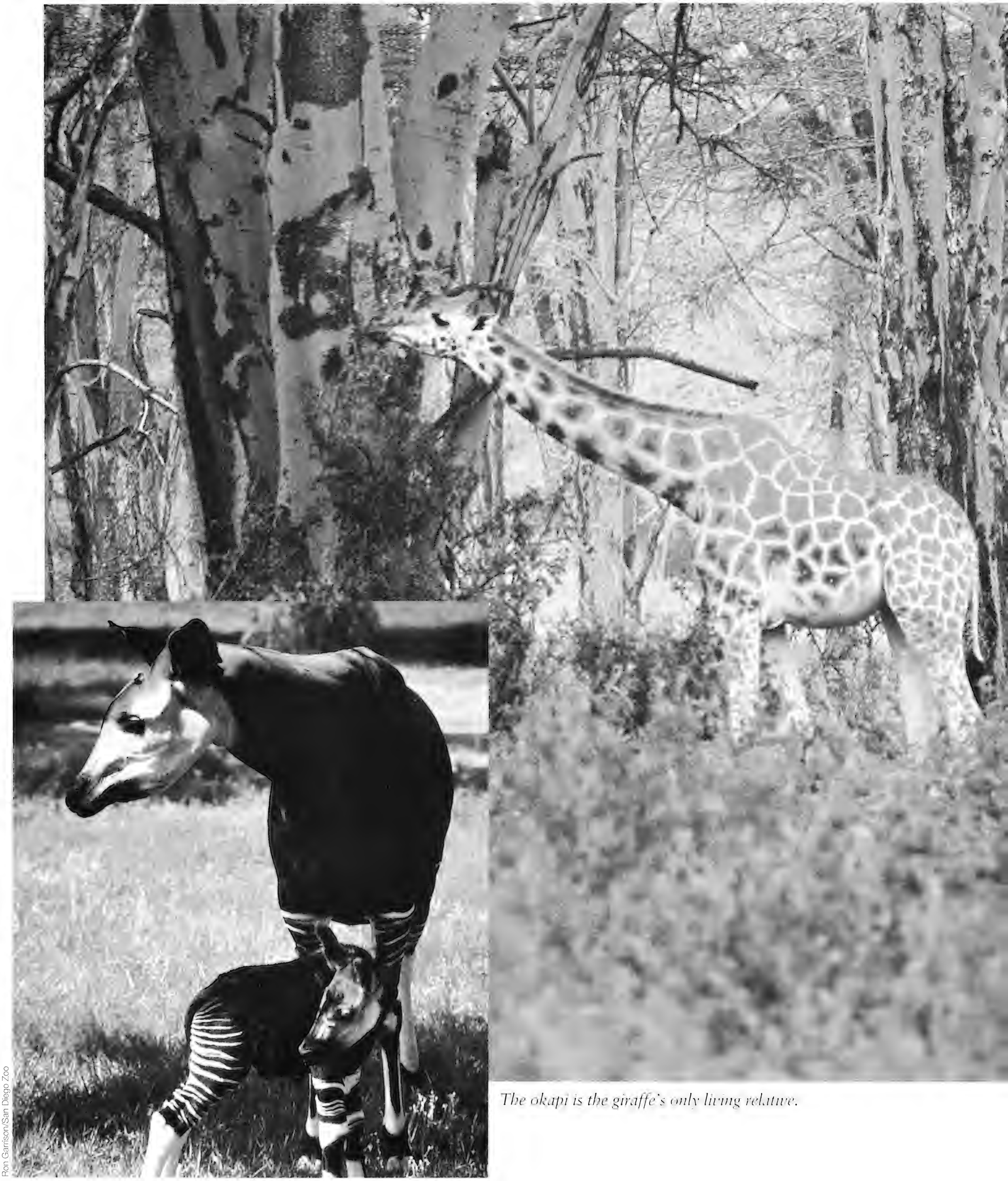
While few biologists have studied giraffes extensively in the wild, we do have a sketchy knowledge of their behavior. However, what we know raises as many questions as answers. Divided into nine subspecies based on coat pattern and horn number, giraffes form herds like many hooved mammals. But unlike most herding hoofed species, which form tight-knit and stable groups, giraffe herds are unusually informal. The fifteen-odd females and young in a herd may be scattered over a considerable distance and may leave and rejoin at will. "The social structure is fluid and not well understood," says Truman Young, a UCD ecologist who studies how giraffe feeding behavior affects the environment. "What is the relatedness of the individuals? Who stays with whom? What are the advantages of staying in a group?"

Males mature sexually at about four years but keep growing until they reach about eight years. While young males often roam together in loose association, older males tend to be solitary. The older, larger bulls are dominant and devote much of their time to patrolling for females in heat. A dominant bull will approach a herd, draw himself up to his full height, and stare at a potential rival. While this is usually enough to make the adversary leave, once in a while a subordinate bull stands his ground and a fight ensues. Giraffes fight by charging and swinging their heads at each other as hard as they can. At up to 25 pounds, their heads are substantial weapons, and the thud of a blow is audible at least 100 yards away. Although violent, these fights normally do not result in injury because the males' nine-inch horns are blunt and covered with skin, and the skin on their necks can be an inch thick. Moreover, their brains are well-protected by skulls that are quite thick and extensively pocketed with sinuses.

When one of the bulls tires of the rapid rain of blows, he flees, leaving the victor free to inspect the cows. Like many animals,

Ever wary, members of a giraffe herd position themselves so that each looks in a different direction.

"If you're watching them, they're watching you."



The okapi is the giraffe's only living relative.

Ron Garrison/San Diego Zoo

Females and young in a giraffe herd may scatter over a considerable distance and leave and rejoin the herd at will.

including cats and horses, male giraffes can tell a female is in heat by testing her urine. The male nudges a female near her tail to stimulate her to urinate and then takes a sample into his mouth. He then pulls his lips back in a characteristic grimace called flehman and uses his tongue to bring urine droplets to openings in the roof of his mouth. These openings are similar to nostrils and lead to an olfactory membrane called the vomeronasal organ (people lack this organ). Presumably the vomeronasal organ can detect hormones indicating that a female is ready to conceive.

The bull goes from cow to cow and herd to herd, sampling urine until he finds a female in heat. He then separates her from the rest of the herd and follows her around for a day or two, repeatedly testing her urine. Between tests he often entwines his neck around hers and browses by her side. Although she usually thwarts his initial attempts to mount by walking forward, leaving him to slide off her rump, eventually she accepts him. Copulation is brief and the pair returns to browsing immediately afterward.

Fifteen months later, the female gives birth in a traditional calving ground. For reasons yet unknown, females will travel great distances to return to the same site to have their babies. Birth appears to be a rude awakening for calves: Emerging head and forefeet first, they drop six feet to the ground, where they lie temporarily stunned by the impact. They recover quickly, however, and stand within 10 minutes of birth. Initially, a newborn hides in foliage near its browsing mother.

After several weeks, the baby joins the rest of the herd. While its mother has been exceedingly attentive up to this point, now she may stray several miles in search of forage, leaving the baby in a small group of calves called a creche. Another mother sometimes stays to guard the creche but often the calves are left apparently alone. Half of the calves are killed by lions, hyenas, and other predators during their first year of life, and the reason for their mothers' near abandonment remains a mystery.

At about six feet, newborn giraffes are taller than the average person. But even so, their small stature relative to adult giraffes makes them easy prey, and the babies grow fast to make up the difference. Newborns can grow as much as an inch each day and calves roughly double their height during the first year.

At about a year, when they are approximately 12 feet tall, young giraffes no longer remain behind in creches when the rest of the herd leaves to forage. Although the herds are scattered, giraffes don't need to be close together to communicate. Their eyesight is so keen that they can see each other a mile away. Hyper-vigilant, giraffes constantly scan their surroundings for predators and sprint as fast as 35 miles per hour at the slightest hint of danger. "If you're watching them, they're watching you," notes Texas A&M's Ginnett. Members of a herd position themselves so that each looks in a different direction, and they guard each other closely when necessary.

Under most circumstances, healthy adults are protected by their tremendous height and their ability to deliver crushing blows with foot-long hooves. On rare occasions, giraffes—particularly mothers defending their young—have been known to kick lions to death. However, giraffes are vulnerable to attack when they bend over to drink or lie down to sleep.

John Seidensticker

Giraffes are vulnerable to attack when they bend over or lie down to sleep.

Drinking is a tricky affair for giraffes because it is the one activity their necks are not long enough for. They simply can't reach the ground! Reaching water entails first bending or splaying their forelegs and then lowering their necks. Righting themselves from this awkward position takes time—a luxury animals don't have when a lion springs from ambush. Water holes are among the most dangerous places on the savanna and at least one giraffe is always on the lookout for predators when the herd lines up for a drink. Zebras, antelope, and other species take advantage of the giraffes' security system and often line up to drink with them.

Fortunately for giraffes, they can go weeks without drinking. But sleeping is another story. Giraffes have to sleep every night, and they are even more vulnerable to attack when lying down than when drinking. This is because standing back up is a lengthy three-step process that involves vigorously swinging their necks backwards and forwards, first to hoist their forelegs to kneeling, then to get on their hindlegs, and finally to get up on their forelegs as well. Giraffes have two strategies to minimize their chances of being attacked while sleeping. As when drinking, at least one member of the herd always stands guard while others sleep. Second, their idea of a good night's sleep wouldn't satisfy even the most manic of us. Giraffes sleep deeply for only five minutes at a time and these naps add up to only about half an hour each day. They do supplement their naps by dozing standing up, but remain alert during these periods, leaving one eye open, and constantly moving their eight-inch ears.

Besides spending a lot of time watching for danger, giraffes spend a lot of time browsing. Like cattle, giraffes are ruminants, eating quickly and barely chewing their food the first time around. They typically browse for several hours after dawn and several more near dusk, reserving the hot middle part of the day for chewing their cud. The up-to-two-ton adults eat as much as 145 pounds of food a day, selecting new leaves, shoots, flowers, sausage-tree fruit, and other nutrient-rich vegetation. Giraffes grasp branches with their long, black, prehensile tongues and strip off the leaves with their comb-like canine teeth, which are broad and divided into several lobes.

While giraffes will eat a variety of shrubs and trees, their favorite food is acacias, up to 60-foot-tall trees that dot the savannas. Acacias are a nearly perfect food for giraffes. The leaves are up to 75 percent water, which may help explain why these animals can go so long without drinking, and contain virtually all the nutrients they need. Only two are in short supply: salt, which giraffes get by licking natural deposits in the ground, and calcium, which they get by chewing bones that they come across.

The only drawback to acacias is that they bristle with stout, pin-sharp thorns up to two inches long. While giraffes feed partly on growing shoots that have soft, immature thorns, they also can—and do—eat hard, mature thorns. "The thorns come out in their dung, still very sharp," says UCD's Young. Giraffes are remarkably well-equipped to deal with these thorns. They can close their nostrils completely, their upper lips are protected by a thick barrier of hair, and they produce great quantities of viscous saliva to help the thorns go down more easily. Moreover, their tongues are nimble enough to reach between thorns to snag a leaf.

It turns out that acacias are also well-equipped to deal with giraffes. Young and his colleagues found that when browsed by giraffes, acacias try to protect their delectable leaves by growing longer thorns. One species, *Acacia xanthophloea*, more than doubles its thorn length in response to browsing. Giraffes typically browse between three and 13 feet from the ground, and in that range *A. xanthophloea* thorns reached about two inches, long enough to extend past the inch-long leaves. But at 16 feet up, the thorns were shorter than the leaves. Thorns were also shorter than the leaves in *A. xanthophloea* near the research camp, where giraffes hardly browsed. This is the first evidence that herbivores can induce plants to increase their thorn length in an attempt to defend their leaves.

Another intriguing aspect of giraffe foraging is that males and females often browse in different parts of the savanna. While males tend to prefer wooded areas, females with babies like open spaces. Young and colleague Lynne Isbell found that the optimal feeding height (based on the number of bites per second) is about 60 percent of adult height, perhaps because their heads are freer to move. But females with babies typically browse in areas where the shrubs are too short to eat at the greatest rate. While no one knows for sure why they do this, Young and Isbell speculate that the mothers sacrifice their foraging efficiency for the safety of their offspring—it is easier to spot predators in open areas.

Answering such questions about giraffe behavior is of more than academic interest. "We need to know how they use their environment because it could help in the future," says Texas A&M's Ginnett. "We're looking down the road for when we do need to manage their habitat." Giraffes are already in trouble in West Africa and those in the eastern parts of the continent face an uncertain future. While giraffes have had the good fortune of not having to share their food with other animals, it may soon prove a tall order to live side by side with more people.

Robin Meadows is a contributing editor to ZooGoer.

ULTRA-MODERN *Matchmaking*

JEFFREY P. COHN

Terri Roth watched and waited patiently as a female cheetah at the Caldwell Zoo in Tyler, Texas, wobbled a bit, then wobbled some more, and finally fell over. The dazed and drowsy cheetah, hit a short time earlier with an anesthetizing dart, was asleep within minutes.

That was the moment Roth, a researcher from the National Zoo, and her colleagues had been waiting for. They quickly loaded the cheetah onto a truck and drove her to the zoo's hospital. There, a team of veterinarians, reproductive physiologists, and zookeepers from the National and Caldwell zoos surgically inserted semen into the female's uterus, in a process called artificial insemination. Born three months later, the cheetah's daughter, named "Jomu," now resides at the National Zoo's Cheetah Conservation Station.

Increasingly, so-called assisted reproduction techniques—including artificial insemination, in vitro fertilization, and embryo transfer—are being used to study and breed endangered animals in zoos. In particular, the National and other zoos have focused their efforts on several of the world's three dozen cat species. Although still mostly at the research stage, this work helps advance our understanding of the basic reproductive biology of wild animals to aid their conservation both in zoos and in the wild.

In **artificial insemination,** scientists collect sperm from a male and insert it either manually into a female's vagina or surgically into her uterus. The surgical technique, developed at the National Zoo's NOAHS (New Opportunities in Animal Health Sciences) Center, uses a long, slender instrument with lenses called a laparoscope that allows scientists to see the uterus inside the abdomen.

The sperm used may be fresh, or it may have been frozen and stored in liquid nitrogen at -196° Celsius, then thawed. Scientists have also developed techniques to freeze embryos just as they begin to develop. Eggs are less commonly frozen because the freezing process usually destroys their viability.

In **in vitro fertilization,** eggs are sucked out of the female's ovary using a small needle with a tube attached to it. Scientists then mix the eggs with sperm in a laboratory dish containing a special culture medium. Finally, the fertilized eggs are put back into the female from whom they were collected or into another female.

Jessie Cohen/NZP

A clouded leopard cub.

In both artificial insemination and in vitro fertilization, females are given hormones first to mimic their natural cycles. In in vitro fertilization, the object is to stimulate the production of as many eggs as possible in the hope that many eggs will be fertilized. In the third assisted reproduction technique—**embryo transfer**—fertilized eggs, whether fertilized in the female and flushed out or inseminated in the lab, are put into a different female. Sometimes, the fertilized eggs are even put into a female of another species in a method called interspecies embryo transfer, which may prove useful in quickly increasing the numbers of an endangered species by transferring embryos from a rare female to a common female.

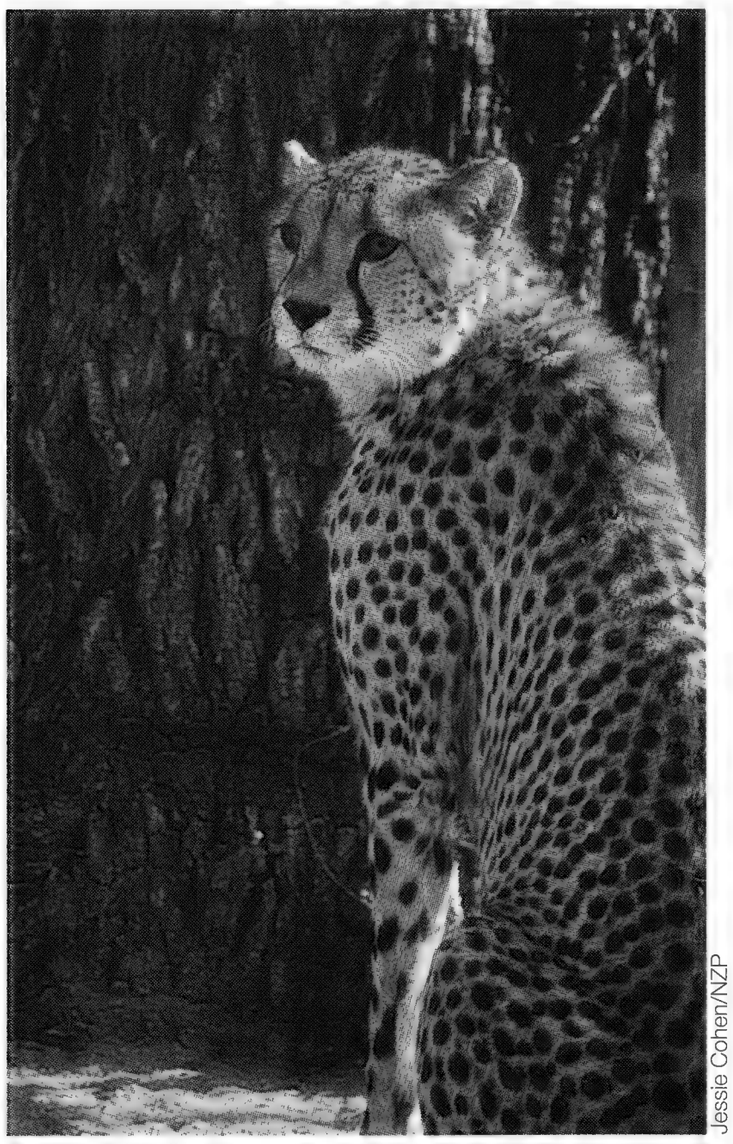
"We are producing knowledge that can later be used to produce babies," says David Wildt, the National Zoo's chief reproductive physiologist and co-director of NOAHS. But, Wildt adds, "We are not using this technology to replace natural breeding. These are tools that can be used to assist conservation." The National Zoo is a leader in assisted reproduction work, but it is not the only zoo using these techniques to better understand and breed wild animals. The Cincinnati and San Diego zoos have long-standing programs as well. More recently, zoos in New Orleans, Omaha, Minnesota, Toronto, and Columbia, South Carolina, have hired reproductive physiologists, many of them trained at the National Zoo. The work often involves close collaboration between these zoos and others.

Assisted reproduction techniques allow zoos to breed rare animals without shipping them from one facility to another. They also let zoos breed genetically important animals that have not bred naturally, such as males and females that don't like each other enough to mate.

Brave New Cats

Nearly all of the world's cats are endangered or threatened in the wild. Habitat destruction and fragmentation, loss of natural prey, and poaching for their skins, bones, and other parts have caused feline populations to plummet. For example, three tiger subspecies are already gone and the number of wild tigers has dropped from 100,000 before World War II to about 5,000 today.

Cheetahs, too, have been hard hit. Only an estimated 9,000 to 12,000 remain in the wild. They are virtually gone from Asia and northern Africa and found only in scattered populations in eastern and southern Africa. There, they are often shot by ranchers because they occasionally kill livestock. And these are just two of the best known endangered cats. Many others face similarly uncertain futures.



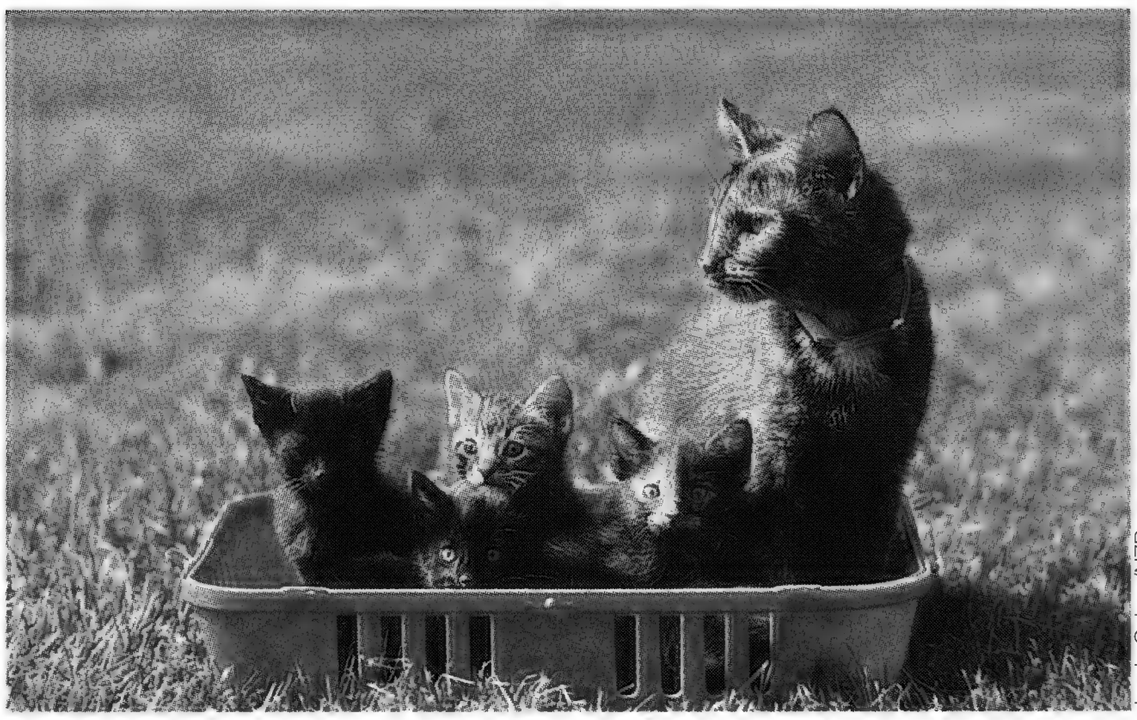
Jessie Cohen/NZP

The Zoo's Jomu, the result of a successful artificial insemination.

Wildt, JoGayle Howard, a reproductive biologist, and other National Zoo researchers have bred tigers and cheetahs, as well as pumas, clouded leopards, ocelots, snow leopards, leopard cats, and domestic cats using artificial insemination or in vitro fertilization. Three of these animals—a cheetah, a leopard cat, and an ocelot—were bred using frozen sperm.

Further, the Zoo's scientists have evaluated the fertility of more than 600 cats from 26 species at 95 zoos and research centers worldwide. They also have monitored the reproductive status of cats of nine species by testing hormones found in their feces. And they have collected sperm from more than 250 cats of 23 species and stored the frozen sperm in a genome resource bank at the Zoo.

The National Zoo's research on cats began in the early 1980s when Wildt, Zoo veterinarian Mitchell Bush, and National Cancer Institute geneticist Stephen O'Brien found that wild and zoo cheetahs were highly inbred, often produced abnormal sperm, and were difficult to breed in zoos.



Jessie Cohen/NZP

Domestic cats helped researchers devise techniques that could later be used to breed wild felines.

In 1989, in an attempt to find out whether cheetahs could breed naturally in zoos, the American Zoo and Aquarium Association asked Wildt and Howard to survey the reproductive status of zoo cheetahs. In response, National Zoo scientists began traveling from zoo to zoo to examine cheetahs' reproductive organs, determine their hormone levels, and collect and test the viability of sperm.

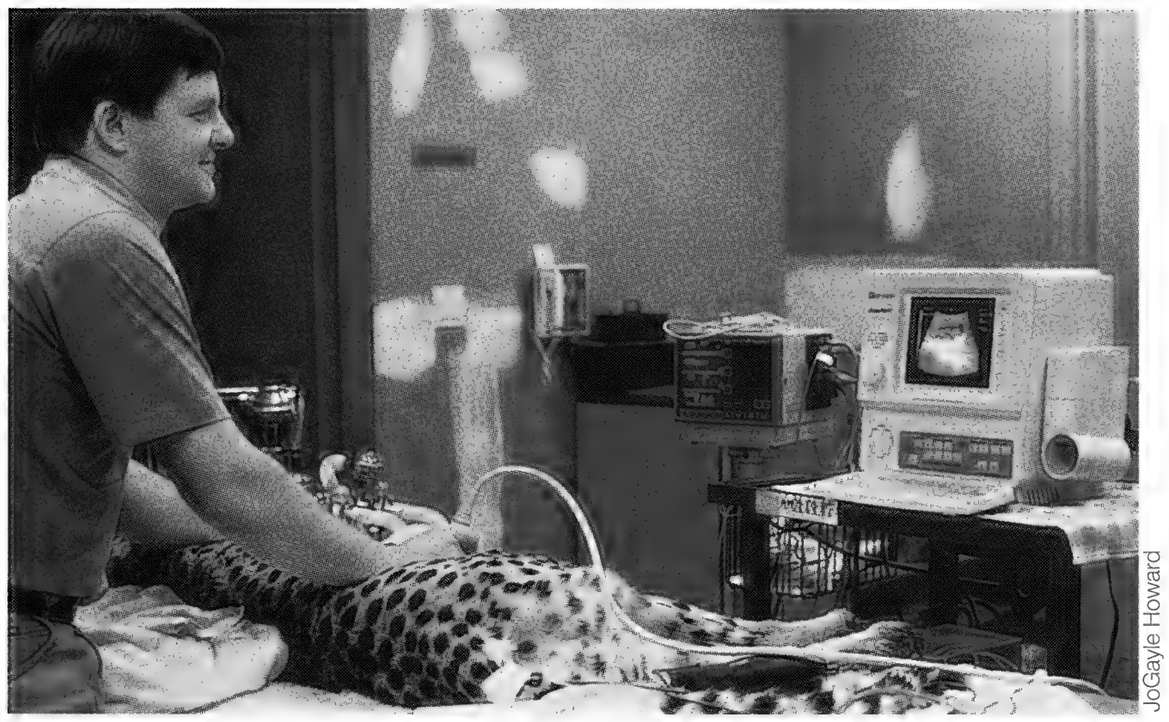
The scientists use a mobile laboratory with 10 trunks crammed with microscopes, laparoscopes, centrifuges, electroejaculators, video cameras, incubators, and ovens. To date, they have examined more than 250 cheetahs in 25 zoos worldwide. Among other findings, Wildt, Howard, and the National Zoo team learned that even though some males' sperm was highly abnormal, the animals could still father young and thus contribute to the genetic diversity of the population.

Even before the survey, Wildt had attempted to artificially inseminate cheetahs, clouded leopards, and tigers at zoos. When early efforts failed, however, researchers turned to the domestic house cat to learn why. In 1984, Wildt, Howard, and Karen Goodrowe, now a reproductive physiologist at the Metro Toronto Zoo in Canada, began studying house cats—which are both abundant and easy to work with—to devise techniques that could later be used with wild felines.

Carefully experimenting, testing, and monitoring to see what worked in domestic cats, the scientists found one reason for earlier problems was that sperm put manually into an anesthetized female's vagina failed to reach the eggs due to poor sperm transport. As a result, Wildt and Howard developed the surgical techniques noted earlier to deposit sperm directly into the female's uterus. They also worked out when and how much hormones to give to stimulate ovulation.

Eighteen domestic cats were artificially inseminated in 1989 using fresh sperm. Nine became pregnant and 15 kittens were born. Earlier, in 1987, eggs from six females were mixed with sperm in a lab dish and put back into the cats. "When it worked, it really worked," says a proud Goodrowe. Five became pregnant and 10 kittens were born. All kittens were later given away as pets.

Next, Wildt and Ann Donoghue, a former NOAHS graduate student, used in vitro fertilization to produce three Siberian tiger



JoGayle Howard

A researcher checks an ultrasound monitor to track a pregnant cheetah's progress.

cubs at the Henry Doorly Zoo in Omaha in 1990. Two more cubs produced by artificial insemination were born in Omaha in 1991, one of which survived. Meanwhile, Howard used the laparoscope for the first time to place semen into a wild cat's uterus. Working with leopard cats, small spotted felines native to Southeast Asia, Howard produced a leopard cat kitten at the Bronx Zoo (now the Wildlife Conservation Park) in 1991. The next year she repeated the procedure, but with frozen semen for the first time. Two leopard cat kittens were born.

Meanwhile, scientists at the Cincinnati Zoo were using similar methods on four small cats—the sand, Indian desert, fishing, and jungle cats, all of which have endangered or threatened wild populations. All but the desert cat breed naturally in zoos, albeit slowly and with high infant mortality. Betsy Dresser, former director of the Cincinnati Zoo's Center for Reproduction of Endangered Wildlife, produced two Indian desert cat cubs in 1989 using in vitro fertilization. Unfortunately, both died of infections. Dresser also successfully fertilized fishing cat eggs in vitro. The embryos are now in frozen storage in Cincinnati.

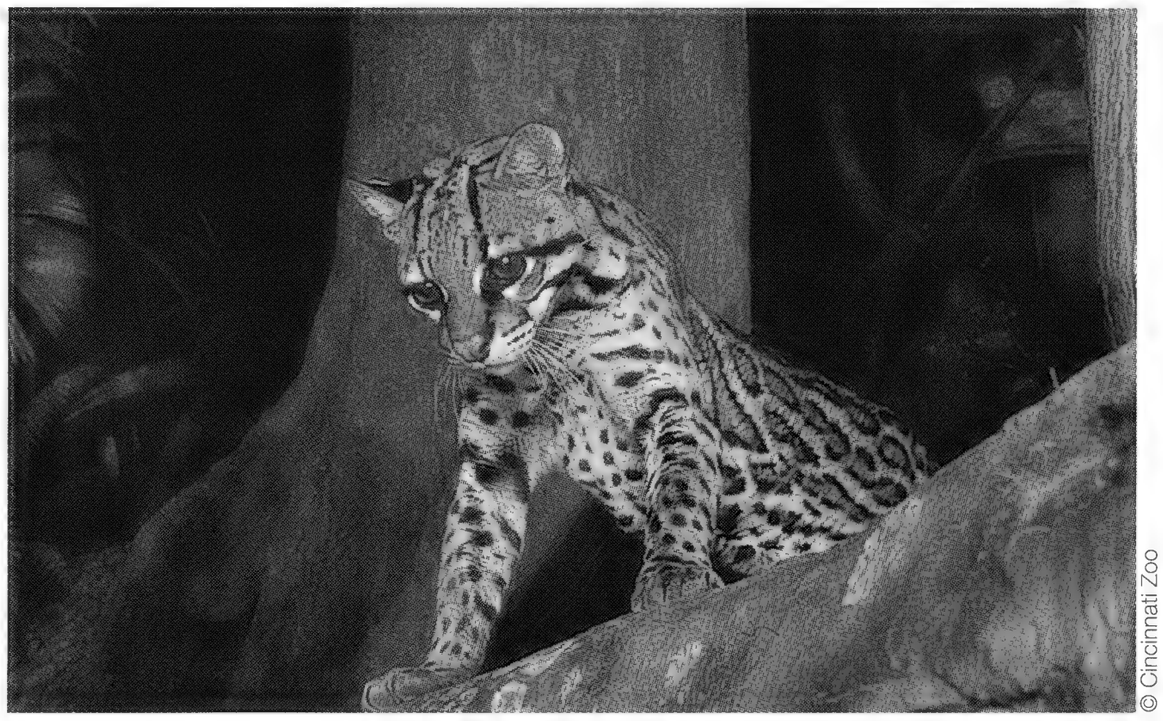
Using yet another method called **sperm injection**, in which individual sperm are put directly into an egg in vitro, Dresser and her associate Earle Pope produced two pregnancies after embryo transfer in the domestic house cat in 1995. "It is a very slow process," says Dresser, now senior vice president of the Audubon Park Zoo's Species Survival Center in New Orleans, of the painstaking scientific work required. "We do not have the luxury of thousands of animals to work with. We cannot repeat experiments."

Back at the National Zoo, scientists have designed tests to determine a cat's reproductive status without capturing the animal and performing surgery. Janine Brown collects and treats feces to determine how much progesterone and estradiol, the primary female sex hormones, are present. "We were operating blindly before," says Brown, a reproductive endocrinologist at the Zoo's Conservation and Research Center (CRC) in Front Royal, Virginia. "It may not be very glamorous work, but we are learning things we had no clue about before and doing it without disturbing the animals."

By measuring hormone concentrations, Brown can tell whether a female cheetah is a good candidate for artificial insemination. She can also tell whether a female is being given too much or too little of the hormones used to stimulate egg development. And, by following a female for weeks after she has mated or been artificially inseminated, Brown can tell if the animal is pregnant.

Brown and her National Zoo colleagues also learned that, for unknown reasons, the cheetahs' ovaries often are shut down in zoos necessitating the use of hormones to better stimulate natural cycles. Using that knowledge plus the work with other cats, National Zoo researchers tried artificially inseminating cheetahs again in 1991. This time, it worked. Since then, seven cheetah females at five different U.S. zoos and breeding centers have given birth to 17 cubs in nine litters through artificial insemination.

Especially important was the birth of a cub at the Rio Grande Zoo in Albuquerque in 1995. The cub's mother had been artificially inseminated with frozen sperm taken from a wild male in



© Cincinnati Zoo

An ocelot.

Namibia in southwestern Africa. This was a major accomplishment, according to Wildt. In fact, the cub's birth showed artificial insemination with frozen sperm not only worked, but that it could be transferred between wild and zoo cheetahs from one continent to another. Further, it kept alive the genes of the cub's father, who was killed later in a territorial dispute with other male cheetahs in a southern African reserve.

Unclouding Breeding Mysteries

More recently, the National Zoo's reproductive physiologists have turned their attention to other, less well-known cats. Take the clouded leopard, a medium-sized, arboreal cat from Southeast Asia. It is listed as endangered because of habitat loss. Virtually nothing is known about wild clouded leopards, which are nocturnal and very secretive.

Clouded leopards have long been hard to breed in zoos because males often attack and kill females when they are put together. As a result, many clouded leopards in zoos have never bred. Artificial insemination could help expand the zoo gene pool by letting males and females produce young without seeing one another.

Janine Brown's work with fecal monitoring has shown that many female clouded leopards, unlike most other cats, are spon-

JoGayle Howard

Researchers hold one of the fruits of their labor.

taneous ovulators. This means that they produce and discharge eggs seasonally even if no male is around, while for most cats the physical process of mating triggers release of hormones that cause the female to ovulate.

Spontaneous ovulation makes it harder to know when to give clouded leopards hormones to stimulate ovulation. "We have to understand their rhythms," says Julie Long, a former National Zoo post-doctoral fellow now at the Riverbanks Zoo in Columbia, South Carolina. As part of a collaborative study, Long has frozen sperm from clouded leopards at the Riverbanks and Nashville zoos and stored it at the National Zoo. She has thawed samples and tested them for fertility. Although no artificial insemination has been attempted using frozen semen, two cubs were born at the Nashville Zoo in 1992 after artificial insemination with fresh semen.

An even more difficult species has been the snow leopard, a white- or soft-gray-coated cat with black spots. Snow leopards live in the Himalaya and surrounding mountains of northern India, southwestern China, and neighboring countries, and are endangered in the wild. Although they breed well in zoos, the American Zoo and Aquarium Association's species survival committee wanted to develop ways to better manage the species. As part of that effort, National Zoo researchers at NOAHS began looking at the snow leopard's reproductive physiology in 1993.

Problems arose almost immediately. Unlike that of other felines, virtually all snow leopard sperm died shortly after being placed in a culture medium. The reason: Snow leopard sperm are unusually pH sensitive compared with that of other cats. "It took us three years to figure out this problem," Roth says. "We eventually were able to determine what the problem was, and we found a culture medium that worked." Bill Swanson, another NOAHS scientist, has since found that sperm from jaguars, black-footed cats, and Geoffroy's cats are likewise pH sensitive.

Assisted reproduction techniques are also being used to study and breed other species in zoos. At the National Zoo's CRC, NOAHS scientists have produced black-footed ferrets and Eld's deer by artificial insemination. Similarly, the Riverbanks Zoo is working with howler monkeys, Eurasian black vultures, and crocodile monitors. And both the San Diego and Toronto zoos are focusing their efforts on the world's wild canids, the latter particularly on the endangered red wolf.

Before the promise of the new technologies can be fulfilled, however, several barriers must be overcome, Wildt says. First, more needs to be known about the basic reproductive biology of most cats and other species. For most species, little is known about reproductive cycles, typical hormone levels, or the normal traits of sperm, eggs, and embryos. Moreover, because details differ from species to species, precise techniques have to be carefully fine-tuned for each.

Second, one-time successes with this or that animal need to be turned into regular occurrences. Scientists often brag about the first artificial insemination of one species or the first embryo transfer in another. But, to date, in only a handful of species have there been repeated successful births using assisted reproduction techniques.

© Cincinnati Zoo

A snow leopard.

Third, steady funding sources are needed to move from the experimental to the commonplace. Nearly all money to support the assisted reproduction work of the National and other zoos now comes from research grants for specific studies.

Fortunately, advances made in recent years are beginning to overcome these barriers. "These are exciting times," the National Zoo's Wildt says of the research work being done in North American zoos. "We're not claiming that assisted reproduction techniques can solve all conservation puzzles. But they can help us find the pieces, and more knowledge gives us a better chance to conserve rare species."

Jeffrey P. Cohn is a Washington, D.C.-based freelance writer specializing in zoo and conservation issues.

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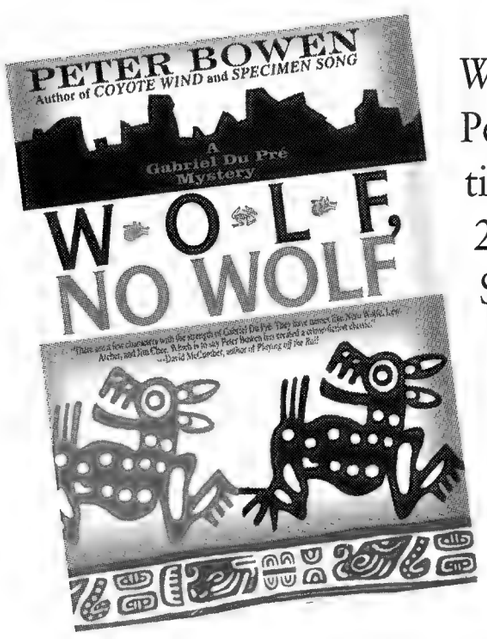
Don't forget the sunscreen for this page turner.
—*John Seidensticker*



Wolf, No Wolf. 1996. Peter Bowen. St. Martin's Press, New York. 213 pp. clothbound, $20.95.

The Wolf Mountains rise from the high plains of eastern Montana. With their deep canyons and towering cliffs, high meadows and imposing forests, these slopes cast long shadows on life in the surrounding ranches and towns. The spell of these mountains lies in their namesake: not what is there, but what is missing—wolves. Emotions run high, shots echo, and bodies pile up when environmentalists and the government reintroduce wolves to the Wolf Mountains. Peter Bowen's memorable Gabriel Du Pre shows how a high plains winter storm can separate newcomers from old hands.Then just as spring renews the land, Bowen leads the reader to ask whether the call of the wolf will replace sheep bells in high mountain pastures.

Grizzly. 1996. Christine Andreae. Worldwide Mystery, New York. 250 pp. paperback, $4.99.

Grizzly hits all the buttons—a contested will, a black sheep son, endangered species, eco-terrorists, capitalist despoilers, mystical Indian ritual, and a no-nonense sheriff. Author Andreae pits Lee Squires, her D.C.-based poet-professor-amateur sleuth, against the ursine inhabitants of the rugged Montana wilderness. But in the close contest, the deadliest species is man.
—*Sarah Lutz*

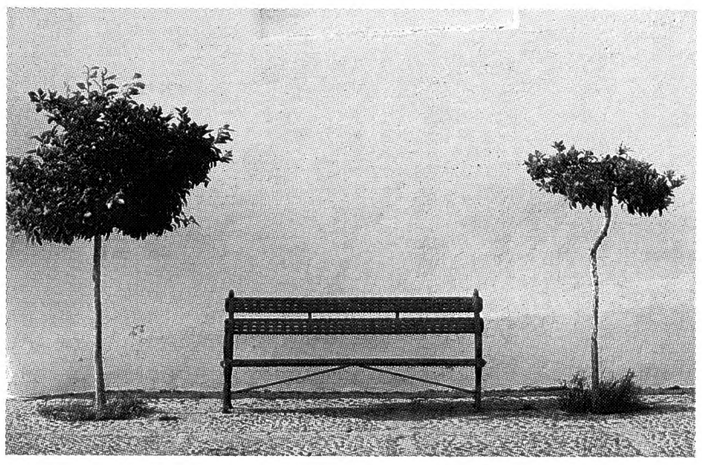
The Devil's Hatband. 1996. Robert O. Greer. The Mysterious Press, New York. 336 pp. clothbound, $21.95.

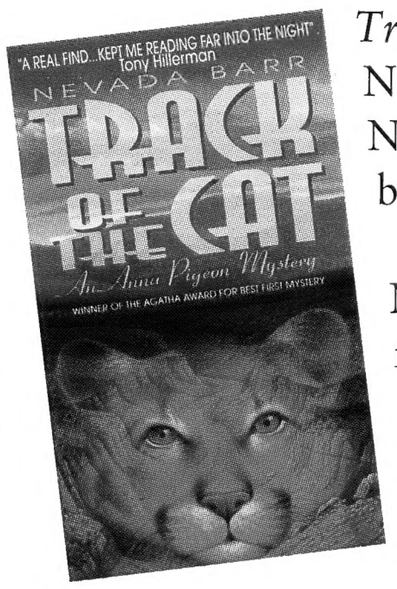
How do you disrupt the economy of a large western state and strike a blow that will forever change the way great tracts of western private and public lands are used? Edward Abby's infamous monkey wrench gang seems downright benign compared with the high-tech bad guys in this supercharged, fast-paced plot spun out in a tangled web by Denver pathologist Robert Greer. Greer detours the reader around the usual Colorado that tourists see. He introduces cultural heritages with proud histories forged by the demands of living in this breathtaking landscape. Are the Coloradans of today up to meeting the challenges new technologies, when put in the wrong hands, can wreak on their environment and lives? Riding in to meet the challenge is an unlikely hero: bail bondsman and sometimes bounty hunter CJ Floyd, on a trail as slippery as a Colorado mountain road after a winter ice storm.
—*John Seidensticker*

Gone Wild. 1995. James W. Hall. Dell Publishing, New York. 449 pp. paperback, $6.50.

Conservationist Allison Farleigh loses a daughter to a rifle blast from an animal poacher's gun in Borneo—or was it a murder planned weeks before? *Gone Wild* takes you on many surprising twists and some predictable turns, all leading to an unexpected conclusion. Wildlife and animal rights issues, the rich and famous, political paybacks, and romance are all part of the thrilling mix. Hall also offers up heart-tugging descriptions of animals being mistreated, as well as some gruesome violence to people. All in all, a good beach read or, if you can't get away, a good companion for your Metro commute.
—*Joy Bramson*

books, naturally





Track of the Cat. 1993. Nevada Barr. Avon Books, New York. 218 pp. paperback, $5.99.

Nevada Barr sets her first mystery in a realm she knows well—the National Park Service. Barr is a park ranger, as is her detective Anna Pigeon. *Track of the Cat* follows Pigeon on the trail of a savage killer—is it a puma or a person?—in west Texas' Guadalupe Mountains National Park. Along the way, Barr offers glimpses at the issues facing parks today, including poaching, rising crime, resentment from park neighbors, and the lonely lives of low-paid rangers. Convincing characters and a rugged setting in puma country add to the enjoyment of this fast-moving mystery.
—Howard Youth

Relic. 1996. Douglas Preston and Lincoln Child. A Tor Book, Tom Doherty Associates, Inc., New York. 474 pp. paperback, $6.99.

Set in the New York Museum of Natural History as it prepares to open a blockbuster new exhibit, *Relic* will keep you turning pages as the staff and police race to find the part-human, part-reptile monster stalking museum staff and visitors alike. Fans of *Jurassic Park* will enjoy the nearly plausible high-tech evolutionary science and the superb surprise ending. Knowing that Preston wrote a history of New York's American Museum of Natural History, on which the book's museum is based, makes the authors' malicious digs at its bureaucracy a hoot. Don't start this one before bed.
—Susan Lumpkin

The Shy Tulip Murders. 1996. Rebecca Rothenberg. The Mysterious Press, New York. 327 pp. clothbound, $21.95.

Did the battle between loggers and tree (and tulip) huggers lead to murder in a small northern California community? Or was it a love quadrangle gone askew? Sleuth Claire Sharples, an agricultural disease specialist, investigates her third mystery in *The Shy Tulip Murders*, in which she shares her knowledge of pecan rot as well as endangered plants, including the mariposa tulips of the title. Rothenberg's loggers are a bit too loutish and her environmentalists a bit too righteous, but the story clips along and the natural local color is well done.
—Susan Lumpkin

Tyger! Tyger! 1996. Richard Hoyt. A Forge Book, Tom Doherty Associates, Inc., New York. 253 pp. clothbound, $21.95.

Time is running out for the tiger across its range from India through Asia to the Soviet Far East. As if declining habitats and disappearing prey were not enough, a new, sinister threat has emerged to finish off these big cats. A conspiracy of forces is working to obtain and hoard the bones and other body parts of the last tigers, with the expectation that demand for them by speculators and traditional medicine practioners will reach unprecedented new heights and value. But a consummate tiger killer has more than just tigers in mind. A trail of young women's bodies leads investigators through an Asian underworld from dilapidated fishing boats with machine-gun-toting hands to seedy dockside bars and on to exclusive suburbs in search of the killer. The deceit, obsession, and greed of the killer's patrons twist this tale into subplots more frightening that the low growl of a cornered tiger.
—John Seidensticker

Thanks to Erin Willis and Barbara Gaunt at MysteryBooks (1715 Connecticut Avenue, N.W., Washington, D.C.) for suggesting these titles.

notes & news

Cooking with the Masters

Six of the Washington area's finest gourmet chefs—Jean-Louis Palladin, Roberto Donna, Francesco Ricchi, Mark Furstenberg, Ann Amernick, and Larbi Dahrouch—have joined together to teach their specialties in the **"Culinary Classes of a Lifetime"** series this fall. Each chef will teach a class on his or her specialty, and class participants will create their own dishes, breads, or pastries. The series, which will be held at L'Academie de Cuisine on Fridays beginning **September 27**, costs $1,000, with proceeds benefitting the National Zoo. Enrollment is limited to 20, and will be filled on a first-come, first-served basis. For more information, call 202.673.4961.

Art for Wildlife's Sake

The Friends of the National Zoo's Wildlife Art Festival—known formerly as the ZooArts Festival—is set for Saturday and Sunday, **September 21 and 22**, from 10 a.m. to 5 p.m. each day. This free two-day celebration of wildlife in art has, over the past two years, grown rapidly. Once again 100 artists and photographers will be on hand, and quite a few big names will be exhibiting this year, including feature artist Rod Frederick, special guest artist Terry Isaac, Alan M. Hunt (last year's feature artist), Larry Fanning, Grant Hacking, Clive Kay, Carel Pieter Brest van Kempen, Jan Martin McGuire, Ron Mayhew, and many others. All artists will have works for sale, and proceeds from art sales benefit education programs at the National Zoo.

A private preview party and art auction will be held Friday evening, **September 20**. And on Saturday evening, there will be a "Vintage Evening" featuring a wine tasting, food, and an opportunity to mingle with attending artists, whose works will be on sale.

For those interested in raising their support to a higher level, benefactor categories are available at both the individual and corporate levels. Packages include behind-the-scenes tours, autographed posters, and entrance to all the festival's special events.

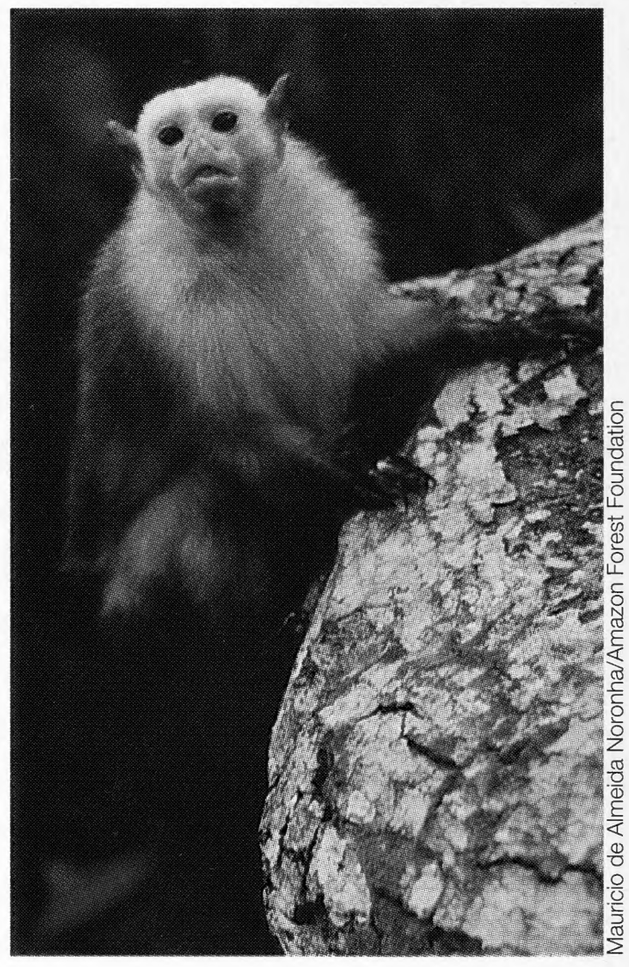
For more information, call Terry Lubar at 202.673.4961.

Are You Ready to Run Wild?

Friends of the National Zoo's fifth annual 5k run, **Running Wild at the National Zoo**, is set for the morning of Saturday, November 2. Runners and walkers will traverse a scenic, pleasantly windy course through the Zoo. Registration fees benefit education programs at the National Zoo. For more information call 202.673.4954.

News Flash...

After months of listening to rumors and keeping their eyes open, two Brazilian zoologists recently discovered a new species of marmoset, the Satere marmoset (*Calithrix saterei*). Marmosets are small, tree-dwelling primates that live mostly in South and Central America, running from branch to branch and tearing at tree bark to get at the gum inside. Named after a group of Indians indigenous to the small primate's habitat in the central Amazon, the Satere marmoset is unusual because of its unpigmented facial skin and distinctive ears. It also has a feature scientists have never before seen on a marmoset: fleshy appendages on the genitalia of both sexes.



Mauricio de Almeida Noronha/Amazon Forest Foundation

This discovery in a remote Brazilian rainforest reminds scientists yet again of the amazing biodiversity still waiting to be discovered in South America. The Satere marmoset is the sixth new monkey species found in Brazil in the last six years. As they investigate previously unexplored areas throughout the South American rainforests, scientists expect to identify even more new species.

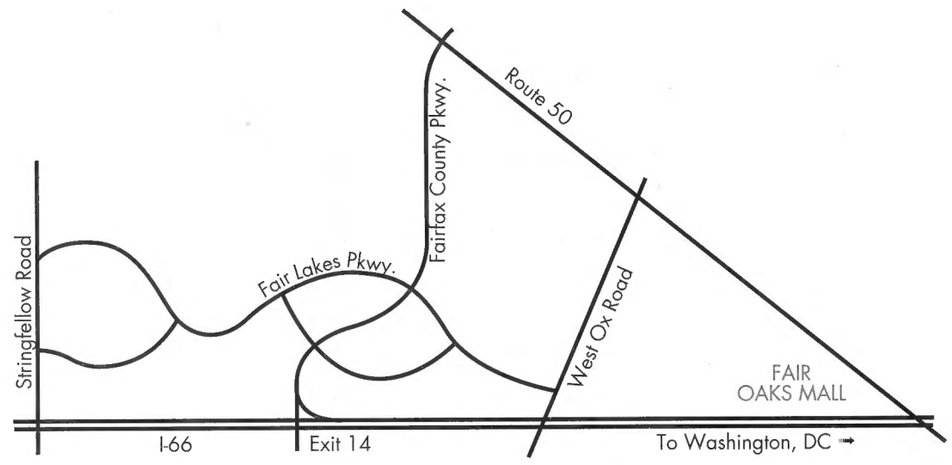
The golden lion tamarin, a close relative to the marmoset, is one of the world's most endangered species and the focus of a long-term conservation effort orchestrated by the National Zoo. The Satere marmoset, however, does not seem endangered because it prefers patches of second-growth forest and is not widely hunted.

—The New York Times, *June 18, 1996, and Conservation International*

Shop All Summer Long!

Visiting the ZooStore at Fair Oaks is a wild idea. Now open all year, the ZooStore offers a wide variety of animal-oriented gift and back-to-school ideas. Choose from a menagerie of plush animals, T-shirts, mugs, sculptures, crafts, games, jewelry, placemats and coasters, tapes and CDs, videos, puzzles, and more.

Don't forget your membership card so you can take advantage of your 20% discount!



ZooStore

Store hours are 10 a.m. to 9:30 p.m., Monday through Saturday, and 11 a.m. to 6 p.m. on Sunday. For directions or more information, call 202.673.4696.

Friends of the National Zoo
National Zoological Park
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